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PROCEEDINGS

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DISCUSSION
OF PROCEEDINGS - SEPARATES

319, 347, 369, 404

IRRIGATION AND DRAINAGE
DIVISION

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DISCUSSION OF SOME IRRIGATION AND DRAINAGE PROBLEMS OF MEDITERRANEAN AND MIDDLE EAST COUNTRIES PROCEEDINGS-SEPARATE NO. 319

M. RAM,[1] A.M. ASCE.—The statements concerning Israel are on the whole correct although the term "gerrymandering" hardly applies. Our specific conditions, however, deserve careful consideration.

A. Sprinkler Irrigation

I completely agree that sprinkler irrigation is more widely used in our country than it should be. Together with a group of specialists we employ all our influence to propagate gravitational methods, wherever suitable. The prevalence of sprinkler irrigation has, however, some reasons, technical and historical, which I summarize as follows:

1. Large areas having rolling topography:
2. Light soils of high permeability:
3. High water table in some localities:
4. Lack of large streams to divert water from for gravitational irrigation. A well yielding 1 c.f. per second was considered, only a few years ago, as highly satisfactory.
5. Farm units of very small size divided into numerous plots for reasons of crop rotation make gravitational irrigation difficult. In large scale farming gravitational irrigation has found widespread use, wherever applicable.

B. Fish Ponds

Our Government exercises a strict control on fish ponds. They are admitted only on soils of inferior fertility. These ponds are fed, as a rule, by brackish water. The problem of the rising water table in the neighbourhood of fish ponds has found the full attention of our Government.

C. Water Duties

The very high water duty of more than 20 acre feet per acre has occurred only in rare instances in some of the fish ponds. Fish ponds account for not more than 25% of the annual water used for irrigation. The average water duty for the whole irrigated area is about 3 acre feet per acre.

D. The Feasibility of Development Projects

"Feasibility of development projects" is a relative term. A State is not to blame for the adverse conditions of nature under which it struggles for its existence. Development plans well adapted to such conditions and carefully checked with regard to best possible utilization of the scarce resources are not merely feasible but become imperative. Not unmindful of past errors we strive for thoroughness in planning in close cooperation with experts of world fame.

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1. Head, Water Utilization Division, Ministry of Agriculture, State of Israel.

WILLIAM H. NALDER, M. ASCE.—This Paper by Mr. Huberty is very timely. It is hoped that it will be read by many members of the Society and others who are interested and may be influential in promoting a better understanding of conditions in and the potential betterment of living standards offered by possible irrigation and related works in the countries discussed and other Middle Eastern lands nearby.

There has been in recent years, it is believed, a greatly increased realization and knowledge, especially among engineers in America, of the great need and also the great possibilities for water resource development, including irrigation, in the countries of the Middle East. The ever pressing and growing need of the peoples of this region for more food and more electric power to improve their standards of living is very evident. The most logical way to meet these needs would appear to be the wise water resource development and utilization of the available water resources. This should be accompanied, as appropriate, with soil rehabilitation and conservation, drainage and improved farming methods.

Unfortunately the general topography and climactic conditions, coupled with established political boundaries between peoples of none too ready willingness to cooperate for the common good combine in many instances to inhibit the best utilization of the natural sources of water by the lands and peoples most in need of it. It will require much study, much perseverance and much wisdom to achieve the optimum results. But the stakes are very large indeed, not only for the welfare of the immediate areas involved, but also for much of the rest of the world.

MARTIN R. HUBERTY, A.M. ASCE.—Mr. M. Ram appears, in the main, to be in agreement with the statements made in the article. On a number of points, particularly sprinkler irrigation and project feasibility, he has expanded the discussion to include reasons which have influenced the practices being followed. These comments do not alter the statements made by the writer. As to the water problems associated with the pond culture of fish, Mr. Ram should be in a good position to evaluate the amounts of water being used. The information obtained by the writer from local inquiries for parts of the Jordan River Valley are higher than those quoted by Mr. Ram.

Wm. H. Nalder raises no points of difference, but pleads for a wider and better understanding of the water resources of the region under discussion.

DISCUSSION OF USE OF COLORADO RIVER WATER IN CALIFORNIA
PROCEEDINGS-SEPARATE NO. 347

R. GAIL BAKER,[1] M. ASCE.—The history of the Colorado River and uses of Colorado River water in California have been well presented by Mr. Raymond Matthew.

The lower Colorado River has two sides: the West, California's side, and the East, Arizona's side. Of the natural drainage basin of the Colorado River, comprising some 240,000 sq. miles, California contains 3,599 sq. miles and Arizona 100,000 sq. miles. California's Colorado basin area is 5% of the state's area. Arizona's Colorado basin area is 97% of the state's area. California's side of the Colorado River contributes approximately 15,000 acre-feet per year or 8/100 of one per cent of the Colorado River Basin water supply. The east Arizona's side contributes nearly all the run-off falling on the entire state.

California's use of Colorado River water now and ultimately will be a very small percentage of the total water available to California from her combined rivers. California's combined rivers waste into the Pacific Ocean many times the flow of the Colorado River allotted for use in the lower basin. Colorado River system water is the only surface water available to all of Arizona. Limiting of Arizona's use of Colorado River water is a limitation on all surface water to Arizona.

Hydro-power and Colorado River water were made available for use in the lower basin by the construction of the Hoover Dam. Started in 1931 and completed in 1936, Hoover Dam and Power Plant produce for California large amounts of the cheapest power. Hoover Dam and Reservoir regulate California's entire irrigation and domestic Colorado River water use. The Boulder Canyon Project Act provided for the construction of Hoover Dam and Power Plant. One prerequisite to starting construction was the passage by California of an act to limit her use of Colorado River water to 4,400,000 acre-feet of firm water plus one half of the surplus available to the lower basin.

California has contracts with the Secretary of the Interior for the delivery of water from Hoover Dam Reservoir totaling 5,362,000 acre-feet annually. This is the total of 4,400,000 acre-feet of firm water, when it is available, plus 962,000 acre-feet of surplus water when, and if, surplus water becomes available and is apportioned. Arizona has the same kind of a contract with the Secretary of the Interior for the delivery of 2,800,000 acre-feet of water on the east side of the Colorado River. Arizona's contract is for firm water equal in priority to California's 4,400,000 acre-feet.

When surplus water is not in the Colorado River to replace evaporation losses from regulating reservoirs, such losses result in a reduction in the available firm water. Arizona contends that this reduction in firm water is an operating loss the same as canal losses are operating losses and should be deducted from the water regulated by the reservoirs. Under this theory, each state's firm water would be reduced in ratio to the use of water by that state when surplus water is not available to replace the evaporation losses.

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1. Engineer Arizona Interstate Stream Commission. Mgr., Sect. Economic Use of Water, Ministry of Agriculture, Tel Aviv, Israel.

Priorities on West, California's Side
of the Colorado River

Priority No.	Agency and Description		Annual quantity in acre-feet
1.	Palo Verde Irrigation District 104,500 acres in and adjoining existing district		
2.	Yuma Project (Calif.) not exceeding 25,000 acres		
3. (a)	Imperial Irrigation District and lands in Imperial and Coachella Valleys to be served by All-American Canal.	Firm	3,850,000
(b)	Palo Verde Irrigation District 16,000 acres of adjoining mesa.		
4.	Metropolitan Water District - Los Angeles, San Diego and others on coastal plain.	Firm	550,000
		Total Firm Water	4,400,000 *
5.	Metropolitan Water District - Los Angeles, San Diego and others on coastal plain.	Surplus	662,000

Priorities on West, California's Side
of the Colorado River

Priority No.	Agency and Description		Annual quantity in acre-feet
6. (a)	Imperial Irrigation District and lands in Imperial and Coachella Valleys to be served by All-American Canal.		
(b)	Palo Verde Irrigation District 16,000 acres of adjoining mesa.	Surplus	300,000
		Total from Surplus	962,000
	Total water contracted for by California for delivery when available		5,362,000

* Less proportion of reservoir losses resulting from regulation of this firm water and not replaced by surplus water.

Priorities on East, Arizona's, Side
of the Colorado River

1.	All Arizona Projects (exclusive of uses of Gila River)	Total depletions in the flow of the main stream of the Colorado River Firm Water	2,800,000 *

* Less proportion of reservoir losses resulting from regulation of this firm water. And less certain rights to lower basin water conceded to New Mexico and Utah.

DISCUSSION OF UNSTEADY FLOW IN OPEN TYPE PIPE IRRIGATION SYSTEMS PROCEEDINGS-SEPARATE NO. 369

R. E. GLOVER,[1] M. ASCE.—The comparison of model test results with Differential Analyzer studies, which the authors present in their paper, contains much that is of value and interest. An observer's first experience with overflowing pipe stands is apt to be a very puzzling one because it appears that the water must be running uphill of its own accord to produce the overflow, and this seems to be a violation of hydraulic fundamentals. It is only through analytical procedures that this peculiar behavior can be explained because the underlying causes are complex. The analyses presented by the authors are of particular value because, by using the Differential Analyzer, they have been able to follow every important detail of the phenomena and to show that it is, after all, explainable on the basis of well-known laws. An inertia drive is the factor which forces the water levels temporarily above their normal running positions.

When surging of troublesome magnitude developed on the Bureau of Reclamation's Coachella installation in 1950, a vigorous program of investigations was initiated to find a means of control. The Coachella distribution system serves an area about 25 miles long and 10 miles wide near Coachella, California. Concrete pipes with baffled pipe stands for pressure control are used for conveying irrigation water in this area. Some of the lines on this system are from 6 to 8 miles long. The program included field studies, model studies, analytical researches and electric analog operation. These investigations developed the use of covers as an inexpensive and practical means of surge suppression, and much of the system is now in successful use under this type of control. Other means of control were also studied. These included the use of gates, vents, modifications of the pipe stand arrangement to avoid air entrainment, and the like, but none of these proved to be as effective as the covers.

The air-driven auto-oscillation described by the authors is a persistent source of initiating oscillations. These are of small amplitude at the point of occurrence and would be of no significance if it were not for the amplifying tendencies of the succeeding pipe reaches. This amplifying tendency was discovered through analytical and experimental researches in the early part of the Bureau's investigations. The ability to amplify goes beyond mere resonance, although resonance is involved, and it is remarkable that a simple hydraulic structure like a pipe stand should possess it. Its behavior is, however, closely analogous to that of an electronic vacuum tube, and it has the same ability to feed energy into an oscillation. Amplifying factors of from 4 to 6 in each pipe reach are not unusual where the natural periods of succeeding reaches are closely similar and flow conditions are favorable.

The authors propose to control surging by the use of properly placed vent pipes. The purpose of these is to permit the release of entrapped air and thereby to destroy the oscillations at their source. This treatment seems

1. Engineer, Bureau of Reclamation, Denver, Colorado.

logical and it is a fact that stable running could be produced in the Bureau model by installing a vent in the first pipe reach. Field experience indicates, however, that stable running cannot usually be obtained in this way. The reason appears to be that the amplification tendencies remain and that there are other sources of initiating oscillations present in addition to those produced by air entrapment and release. It seems probable that a short line with perhaps no more than three or four pipe stands could be stabilized by vents, but in long lines the amplification factors run into almost astronomical figures. Take, for example, a line 6 miles long with pipe stands at quarter-mile intervals. There would be 24 pipe reaches in such a line, and if each reach had an amplification factor of 4 the over-all amplification possible for an initiating oscillation originating in the first reach would be 4^{23}. This is a tremendous amplification potential which indicates that the line would be able to build the most minute initiating oscillation into a violent surge before the end of the line was reached. Field experience indicates that gusts of wind blowing over the tops of open pipe stands are quite capable of creating adequate initiating oscillations. The process of making and cutting off deliveries is also a fruitful source of initiating oscillations. The fact that these are of a temporary nature does not mitigate the severity of the surges they produce in an unstable line. There may be other unidentified sources of initiating oscillations but at any rate field experience indicates that they are always present.

Some auto-oscillation tendencies may remain even though vents are used, because the best position for the vent varies with the flow. With lower velocities than those for which the vent placement is best adapted a bubble may form between the vent and the pipe stand, while at higher velocities a bubble may form downstream at the vent itself. The auto-oscillation produced under these conditions is much weaker than it would be if the vent were absent but with sufficient amplification downstream.it can produce surging.

The use of covers provides a means for grouping numbers of reaches into systems which behave as a unit but which have periods much different from those of the individual reaches. Not only can the number of oscillating systems be drastically reduced by this means but the grouping can be chosen to destroy or reduce the possibility of resonance. They therefore provide a powerful and positive means of surge control which is effective against disturbances arising from any source.

DISCUSSION OF IRRIGATION POTENTIALITIES IN ARKANSAS PROCEEDINGS-SEPARATE NO. 404

GEORGE H. HARGREAVES,[5] A.M. ASCE.—Important irrigation developments in humid areas are long overdue as such developments offer possibilities of meeting increasing demands for food production for long periods of increasing world population. Irrigation in areas of high rainfall is not new as important irrigation developments were made by the French in the Aux Cayes Plain of Haiti almost 200 years ago. This area has a mean annual rainfall of eighty-three inches. As pointed out by Mr. Berg, these developments depend for their success upon the solution of many problems, one of the most important of which is education in irrigation requirements and practices.

The assumption by Mr. Berg that future crop distribution will be the same after irrigation development gives too conservative a picture of future benefits. Irrigation permits the introduction of new crops and requires a complete change in farming methods. It should not be considered as merely an insurance against drought, as assumed by Mr. Berg, but as a means necessary for a transition to a diversified, intensive, stable agriculture employing new crops, new techniques, fertilizers and soil building rotations.

The Lowery-Johnson method of computing consumptive use appears to give a reasonable picture of annual and monthly irrigation requirements for Arkansas. Computation or measurement of the month by month consumptive use by various crops will, however, give a much clearer picture of irrigation requirements and of future probable yields under irrigation.

Based upon a comparison of climactic data and the formulae given by Blaney,[6] it appears that the consumptive use of water by irrigated crops in Arkansas is very similar to that of the same crops grown at Davis, California. This can be more carefully checked by comparing monthly Weather Bureau type pan evaporation rates for Arkansas with those at Davis.

The consumptive use of some irrigated crops grown at Davis in acre inches per acre by months is given in the table on the following page.

These consumptive use data indicate that oats and other small grains will, except during exceptional years, show little response to irrigation. Grain sorghums should show a fair increase in yield, corn yields may be expected to markedly increase and cotton yields should increase still more. It is indicated that yields of most fruits and vegetables grown without irrigation will be low. As dairy production is already of some importance it appears that the use of high yielding clovers under irrigation may be an important factor in increasing irrigation benefits beyond those anticipated based upon the present crop distribution and yields. For fruit crops moisture deficiencies in any one year, by decreasing tree growth, decrease yields in future years. As is the case with soil building rotations made possible through irrigation, the irrigation of fruit produces cumulative or increasing benefits.

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5. Civil Engr., Inst. of Inter-American Affairs, Port-au-Prince, Haiti.

6. Blaney, Harry F., A.S.C.E. Transactions, Vol. 117, 1952, Pages 954 and 965.

Table 1

CROP	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	TOTAL
Alfalfa [a]	1.5	3.9	5.3	6.5	8.0	6.6	5.0	2.0	1.2	40.0
Beans [a]				1.5	3.0	6.5	4.0			15.0
Corn [a]				1.2	4.2	4.1	2.0	0.5		12.0
Cotton [b]			1.6	2.4	6.0	5.5	2.5	1.3		19.3
Fruit (Deciduous) [a]	0.5	2.5	4.0	7.2	7.7	5.4	3.4	1.8		32.5
Grain Sorghums [a]			0.6	3.0	4.2	3.0	1.2			12.0
Grain and Hay [a]	1.8	4.2	4.8	1.2						12.0
Grapes (Muscat) [a]		0.7	2.0	2.5	3.4	2.6	2.0	0.8		14.0
Ladino Clover [a]	1.8	4.5	6.0	7.5	9.0	7.5	5.5	2.2		44.0
Truck [c]		1.2	3.0	6.0	5.4	5.4	3.6	1.8		26.4

a. Univ. of Calif., Col. of Agr., Extension Service, Davis, California, File 12.1 by L. J. Booher. 1948.

b. Cotton Irrigation Investigations in San Joaquin Valley, California, by Frank Adams, F. J. Veihmeyer and Lloyd N. Brown. University of Calif., Col. of Agr., Bull. 668, 1942.

c. State of Calif., Dept. of Public Works, Div. of Water Resources, 1945. Irrigation Requirements of Calif. Crops. Bull. 51.

PROCEEDINGS-SEPARATES

The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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JULY: 457(AT), 458(AT), 459(AT)[e], 460(IR), 461(IR), 462(IR), 463(IR)[e], 464(PO), 465(PO)[e].

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a. Beginning with "Proceedings-Separate No. 200," published in July, 1953, the papers were printed by the photo-offset method.
b. Presented at the Miami Beach (Fla.) Convention of the Society in June, 1953.
c. Presented at the New York (N.Y.) Convention of the Society in October, 1953.
d. Beginning with "Proceedings-Separate No. 290," published in October, 1953, an automatic distribution of papers was inaugurated, as outlined in "Civil Engineering," June, 1953, page 66.
e. Discussion of several papers, grouped by divisions.
f. Presented at the Atlanta (Ga.) Convention of the Society in February, 1954.
g. Presented at the Atlantic City (N.J.) Convention in June, 1954.

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